

CLAIMS

What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. A method for fabricating a patterned copper structure which comprises providing a dielectric material on a substrate, providing at least one trench/via in the dielectric material; providing a liner on the bottom and sidewalls of the at least one trench/via and on horizontal surfaces of the dielectric material in the vicinity of the at least one trench/via;
depositing copper in the at least one trench/via on the liner; and selectively etching the copper to recess the copper with respect to the top surfaces of the dielectric.
2. The method of claim 1 wherein the etching comprises electroetching.
3. The method of claim 1 wherein the etching comprises chemical etching.
4. The method of claim 1 where the selective Cu etching is followed by blanket deposition of one or more barrier or dielectric materials.
5. The method of claim 4 where said blanket deposition is followed by planarization for removing liner from the horizontal surfaces of the dielectric.
6. The method of claim 1 where the selective Cu etching is followed by the selective deposition on the Cu of one or more materials by electrolytic plating.
7. The method of claim 6 where said materials are selected from the group of Co, CoP, CoWP, CoMoP, Ni, NiP, NiWP, NiMoP, NiW, NiMo, CoMo, NiFe, CoFe, NiFeP, CoFeP, NiB, CoB, NiFeB, CoFeB, NiCo, NiCoP, NiCoB, NiWB, NiMoB, CoWB, CoMoB, CoV, NiV, CoFeV, NiFeV, NiCoV, NiCoFeV, NiCo, Ru, Re, Pt, Pd, Rh, Os, NiPd, CoPd, Pb, Sn, Sb, and In.
8. The method of claim 7 wherein said electrolytic plating is followed by planarization for removing liner from the horizontal surfaces of the dielectric.

9. The method of claim 1 where the selective Cu etching is followed by the blanket deposition of one or more metals or alloys.
10. The method of claim 9 where said metals or alloys are selected from the group consisting of Ta, TaN, TaSiN, W, WN, Co, CoP, CoWP, CoMoP, Ni, NiP, NiWP, NiMoP, NiW, NiMo, CoMo, NiFe, CoFe, NiFeP, CoFeP, NiB, CoB, NiFeB, CoFeB, NiCo, NiCoP, NiCoB, NiWB, NiMoB, CoWB, CoMoB, CoV, NiV, CoFeV, NiFeV, NiCoV, NiCoFeV, NiCo, Ru, Re, Pt, Pd, Rh, Os, NiPd, CoPd, Pb, Sn, Sb, and In.
11. The method of claim 10 where said deposition is followed by planarization for removing layers on horizontal surfaces of the dielectric material.
12. The method of claim 9 where said blanket deposition of a metal or alloy is followed by the blanket deposition of a dielectric material.
13. The method of claim 12 where said deposition is followed by planarization for removing layers on horizontal surfaces of the dielectric material.
14. The method of claim 6 wherein said selective deposition by electrolytic plating is followed by the blanket deposition of a metal or alloy.
15. The method of claim 14 which further comprises planarization following said blanket deposition.
16. The method of claim 1 which further comprises removing said liner from horizontal surfaces on said dielectric followed by selectively seeding the copper and then plating a capping layer on the seeding by electroless plating.
17. The method of claim 16 wherein said electroless plating is followed by blanket deposition of a metal or alloy.
18. The method of claim 17 wherein said blanket deposition is followed by planarization.

19. A method for fabricating a patterned copper structure which comprises providing a dielectric material on a substrate;
- providing a liner on the bottom and sidewalls of the at least one trench/via and on horizontal surfaces of the dielectric material in the vicinity of the at least one trench/via;
- depositing copper in the at least one trench/via on the liner for filling the at least one trench/via; and
- selectively electroplating a metal or alloy on the copper.
20. The method of claim 19 where said materials are selected from the group of Co, CoP, CoWP, CoMoP, Ni, NiP, NiWP, NiMoP, NiW, NiMo, CoMo, NiFe, CoFe, NiFeP, CoFeP, NiB, CoB, NiFeB, CoFeB, NiCo, NiCoP, NiCoB, NiWB, NiMoB, CoWB, CoMoB, CoV, NiV, CoFeV, NiFeV, NiCoV, NiCoFeV, NiCo, Ru, Re, Pt, Pd, Rh, Os, NiPd, CoPd, Pb, Sn, Sb, and In.
21. The method of claim 19 which further comprises planarizing after the electroplating for removing liner from the horizontal surfaces of the dielectric.
22. The method of claim 19 wherein said selective deposition by electrolytic plating is followed by the blanket deposition of a metal or alloy.
23. The method of claim 22 which further comprises planarization of following said blanket deposition.
24. The method of claim 19 wherein the metal or alloy is applied through a nozzle for the selective electroplating and the nozzle is circular with a diameter smaller than the diameter of the substrate for reducing the overall current during the electroplating and wherein the electroplating is carried out under substantially constant current conditions.
25. The method of claim 6 wherein the metal or alloy is applied through a nozzle for the selective electroplating and the nozzle is circular with a diameter smaller than the diameter of the substrate for reducing the overall current during the electroplating and wherein the electroplating is carried out under substantially constant current conditions.

26. The method of claim 2 wherein an etchant is applied through a nozzle for the electroetching and the nozzle is circular with a diameter smaller than the diameter of the substrate for reducing the overall current during the electroetching and wherein the electroetching is carried out under substantially constant voltage conditions.
27. A patterned upper structure comprising a substrate having a dielectric material on the substrate wherein the dielectric material contains at least one trench/via therein;
a liner located on the bottom and sidewalls of a liner of the at least one trench/via;
copper located on the liner in the at least one trench/via; and a capping structure located on top of the copper and comprising a layer containing at least one member selected from the group consisting of ruthenium, rhenium, osmium, and rhodium.
28. The copper structure of claim 27 wherein the copper is recessed with respect to the upper surfaces of the dielectric.
29. The copper structure of claim 28 wherein a layer containing CoWP is located directly on the copper between the copper and the layer containing the at least one member selected from the group consisting of ruthenium, , rhenium, osmium, and rhodium.
30. The copper structure of claim 29 wherein the layer containing ruthenium is planar with or recessed with respect to the upper surface of the dielectric.
31. The copper structure of claim 27 wherein a layer containing CoWP is located directly o the copper between the copper and the layer containing the at least one member selected from the group consisting of ruthenium, rhenium, osmium, and rhodium.
32. A patterned upper structure comprising a substrate having a dielectric material on the substrate wherein the dielectric material contains at least one trench/via therein;
a liner located on the bottom and sidewalls of a liner of the at least one trench/via;
copper located on the liner in the at least one trench/via; and a capping structure located directly on top of the copper and compressing a first metal or alloy layer selected from the group consisting of Co, CoP, CoWP, CoMoP, Ni, NiP, NiWP, NiMoP, NiW, NiMo, CoMo, NiFe, CoFe,

NiFeP, NiB, CoB, NiFeB, CoFeB, NiCo, NiCoP, NiCoB, NiWB, NiMoB, CoWB, CoMoB, CoV, NiV, CoFeV, NiFeV, NiCoV, NiCoFeV and NiCo; and

a second metal or alloy layer selected from the group consisting of Ru, Re, Pt, Pd, Rh, Os, NiPd, CoPd, Pb, Sn, Sb, and In.

33. The copper structure of claim 32 wherein the copper is recessed with respect to the upper surfaces of the dielectric.

34. The copper structure of claim 33 which said second metal or alloy layer is planar with or recessed with respect to the upper surface of the dielectric.

35. The copper structure of claim 32 wherein further comprises a layer of dielectric located above the second metal or alloy layer.

36. The copper structure of claim 27 which further comprises a layer of dielectric located above the layer containing ruthenium.

37. The copper structure of claim 31 which further comprises a layer of dielectric located above the layer containing at least one member selected from the group consisting of ruthenium, rhenium, osmium, and rhodium.

38. The product obtained by the process of claim 1.

39. The product obtained by the process of claim 19.

40. An apparatus for etching or plating comprising a wafer-holding fixture that permits wafers rotation and another fixture, substantially parallel to the first, which is segmented in ring-shaped segments that can be electrically isolated from each other, and capable of ejecting the electrolyte in doughnut shaped flow regions of progressively increasing or decreasing internal diameter.

41. An apparatus for etching or plating comprising a wafer-holding fixture that permits wafers rotation and another ring-shaped fixture, substantially parallel to the first, whose area can be

changed such that the electrochemical reactions on the wafer are localized and occur in the regions facing the ring-shaped counter electrode.

42. The apparatus of claim 41 where said ring-shaped fixture is capable of ejecting electrolyte to locally fill an interelectrode gap with a localized doughnut shaped flow whose area changes according to the shape of the electrode.